Responses to Editor:

Comments to the author

Please make final adjustments as suggested by the referee. Please refrain from over-using the term "long-term". Climatology typically uses 31 years as baseline. That should be a benchmark for this word. You could write "a 20-year consistent time series", for example.

Response: Thanks for your efforts in evaluating our manuscript. According to your and the reviewer's suggestion, we have replaced the term "long-term" as "18-year internally consistent time series". We use "18-year" but not "20-year" since there are 18 years from 2002 to 2019.

Other minor revisions, such as equation number, symbols and grammar, are also made in this version.

Responses to Reviewer:

I see that the authors have invested a lot of effort to improve their manuscript. Many of my concerns are now addressed in the revised version. Many thinks are better explained and outlined in the revised version.

Response: Thanks for your careful reading and comments. The point-to-point responses are below.

I have two remaining comments:

(1) An argument is made that the data set put forward here is "long-tem": 2002-2019 While 2002-2019 is a long time period, this is much shorter that many reanalyses (e.g. ERA5). I think the point is that one has an internally consistent data set for the period 2002-2019 here.

Response: Thanks for your good suggestion. According to your and the editor's suggestion, we have replaced the term "long-term" as "18-year internally consistent time series".

(2) In the derivation of your equations (R2) you compare the value of the radius of the earth with u-bar. But these quantities do not have the same unit so they cannot directly be compared. I think what you want to do is to compare the magnitude of the two terms on the left-hand side of this equation (which have the same unit) and demonstrate that the first term can be neglected against the second term.

Response: Thanks for your careful derivations. We use the same equation numbers to revise this point.

Thus, Eq. (3) can be simplified to

$$\frac{\bar{u}^2}{a} + 2\Omega\bar{u} = -\frac{1}{a\bar{p}}\frac{\partial^2 \bar{p}}{\partial \varphi^2} \tag{R2}$$

According to Fleming et al. (1990) and Smith et al. (2017), the monthly mean zonal mean wind is in the range of $\pm 75 ms^{-1}$. Thus, the term $\bar{u}^2/a$ is one to two orders smaller than $2\Omega\bar{u}$. After neglecting the term $\bar{u}^2/a$, we can get $\bar{u}$ at the equator as,

$$\bar{u} = -\frac{1}{2\Omega a\bar{p}}\frac{\partial^2 \bar{p}}{\partial \varphi^2} \tag{4}$$

We have added the following in the text:

To apply Eq. (3) at the equator, one need to differentiate Eq. (3) with φ. As $\varphi \to 0$, we have $\tan\varphi \to \varphi$, $\sin\varphi \to \varphi$. Thus, Eq. (3) can be simplified as (Fleming et al., 1990),

$$\frac{\bar{u}^2}{a} + 2\Omega\bar{u} = -\frac{1}{a\bar{p}}\frac{\partial^2 \bar{p}}{\partial \varphi^2}. \tag{4}$$

According to Fleming et al. (1990) and Smith et al. (2017), the monthly mean zonal mean wind is in the range of ±75ms-1. Thus, the term $\bar{u}^2/a$ is one to two orders smaller than $2\Omega\bar{u}$ and can be neglected. Then, $\bar{u}$ at the equator can be expressed as (Fleming et al., 1990; Swinbank & Ortland, 2003),

$$\bar{u} = -\frac{1}{2\Omega a\bar{p}}\frac{\partial^2 \bar{p}}{\partial \varphi^2}. \tag{5}$$